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(54) **Self-propelled three-wheel vehicles**

(57) A steerable front wheel 19 of relatively large diameter is mounted in a fork 20 on which a head section 2 of the vehicle frame is steerably supported. A load-bearing rear section 3 of the vehicle frame is supported on wheels 7 mounted at the sides of the vehicle. The steerable front wheel 19 is provided with a positive displacement hydrostatic motor accommodated in the hub 21 of the wheel 19. Hydraulic fluid is supplied under pressure to the motor from a hydraulic pump driven by a diesel engine, both these units being housed beneath cover 36.

The vehicle is suitable for carrying a load over difficult terrain and is economical in construction and operating costs.

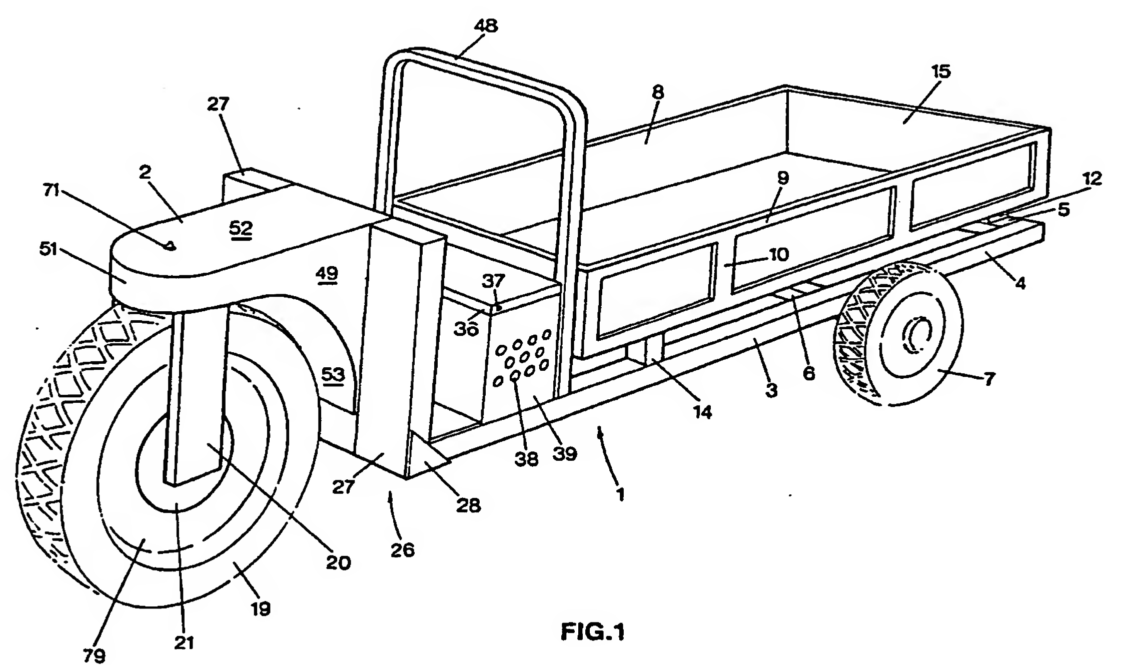

FIG.1

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

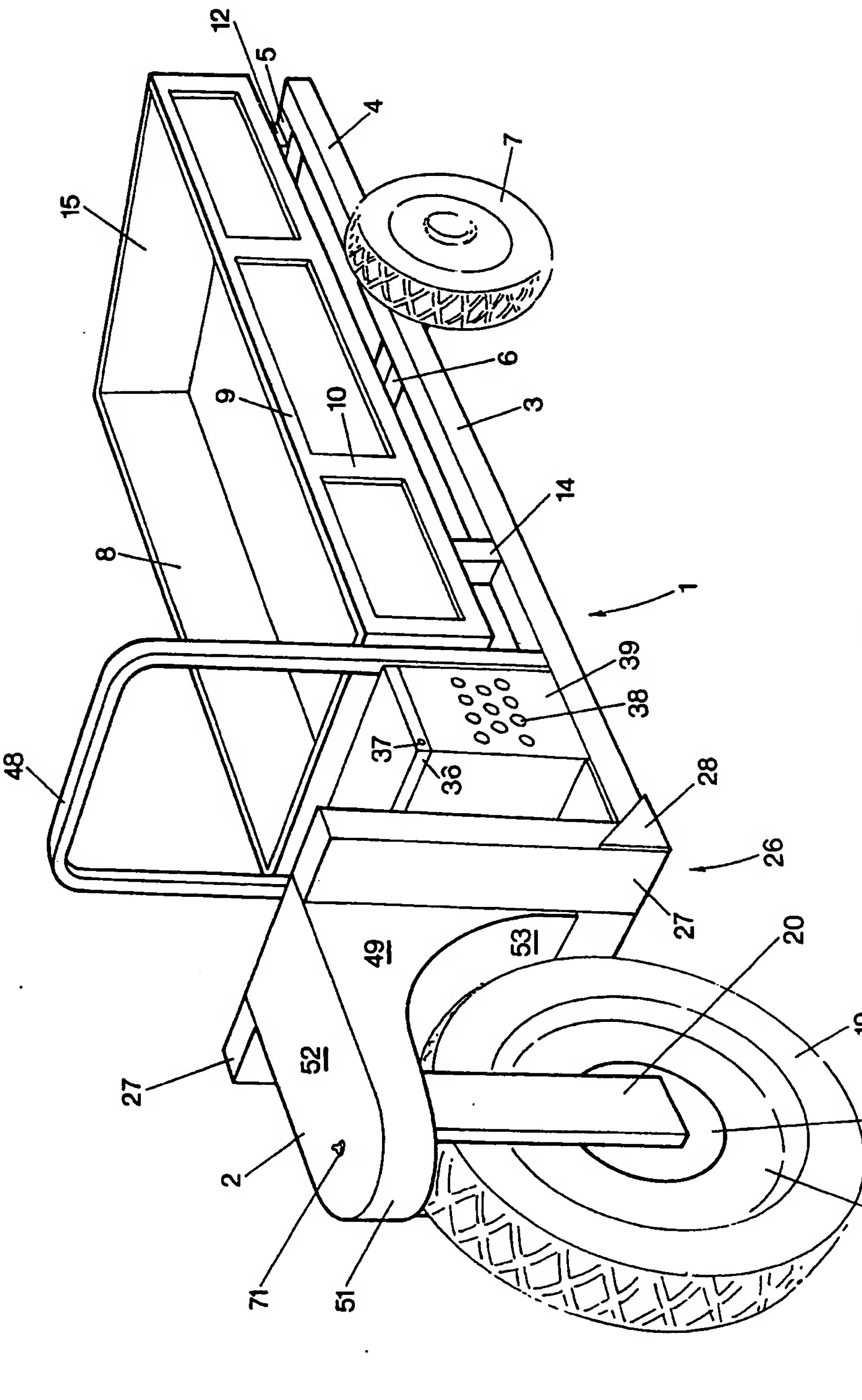
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FIG.1

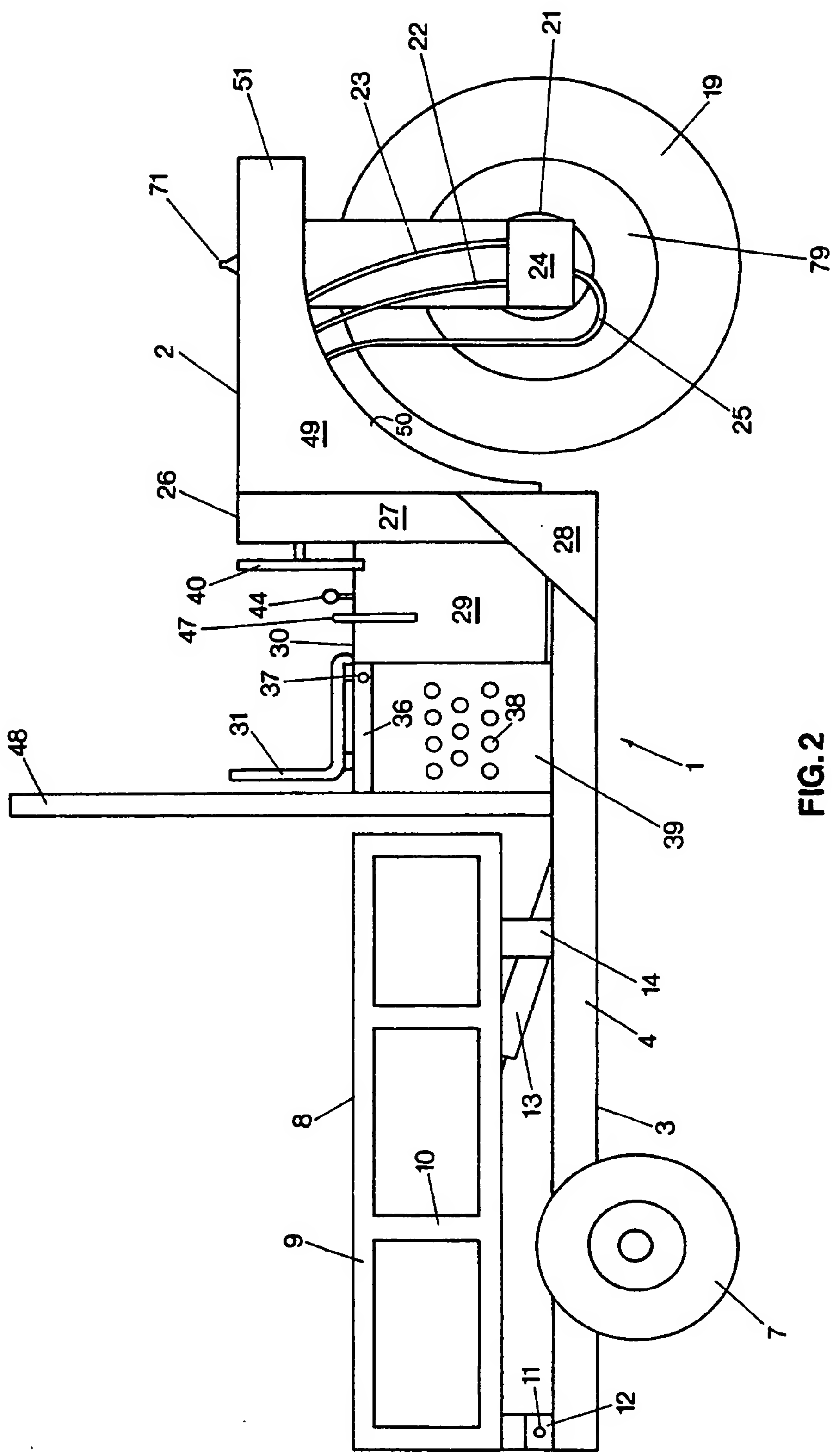

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FIG.2

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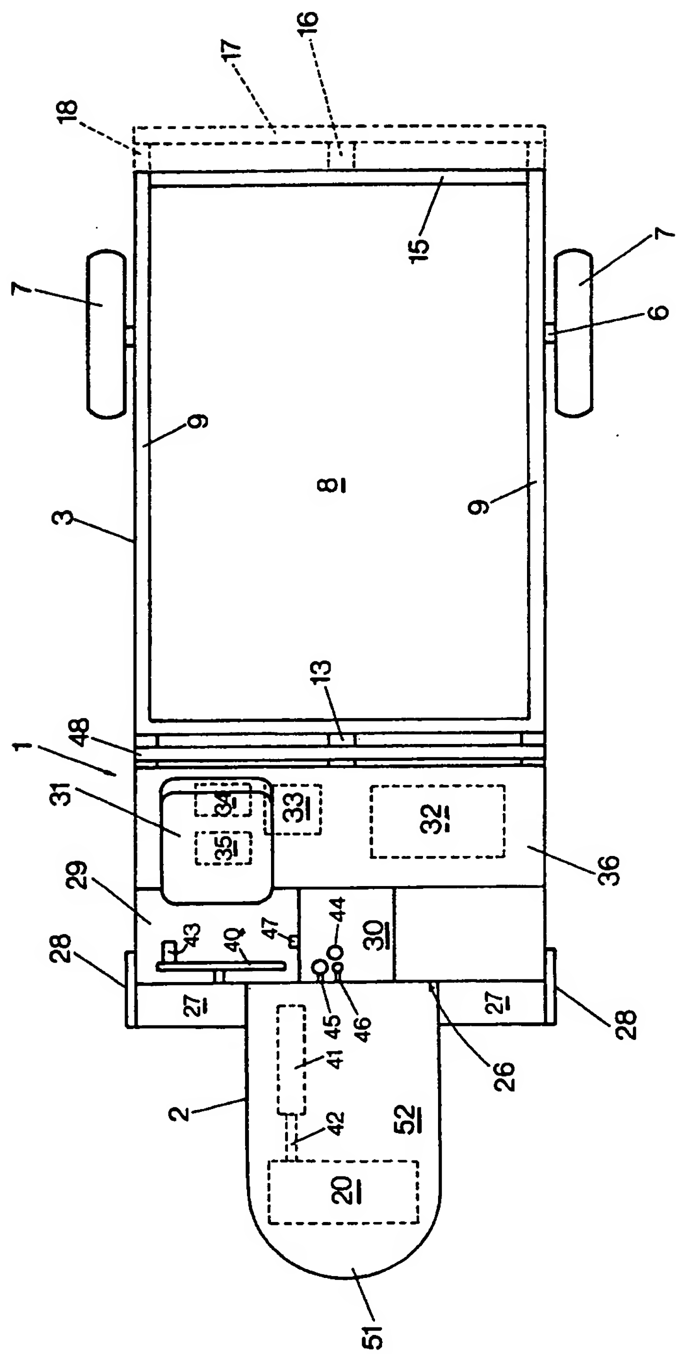

FIG.3

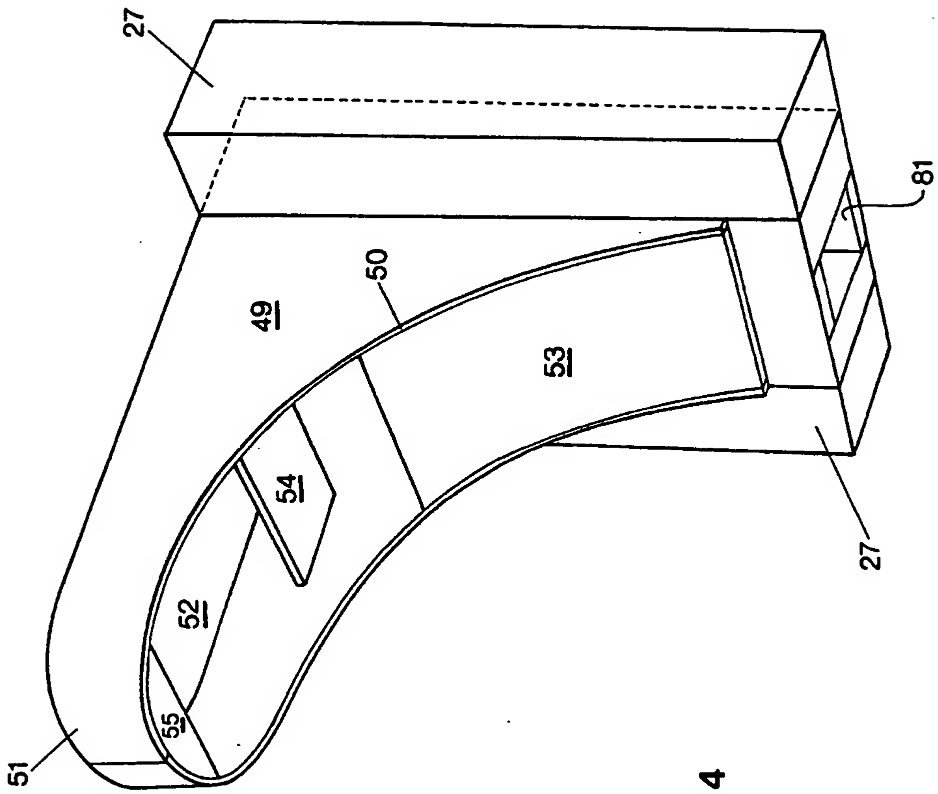

FIG. 4

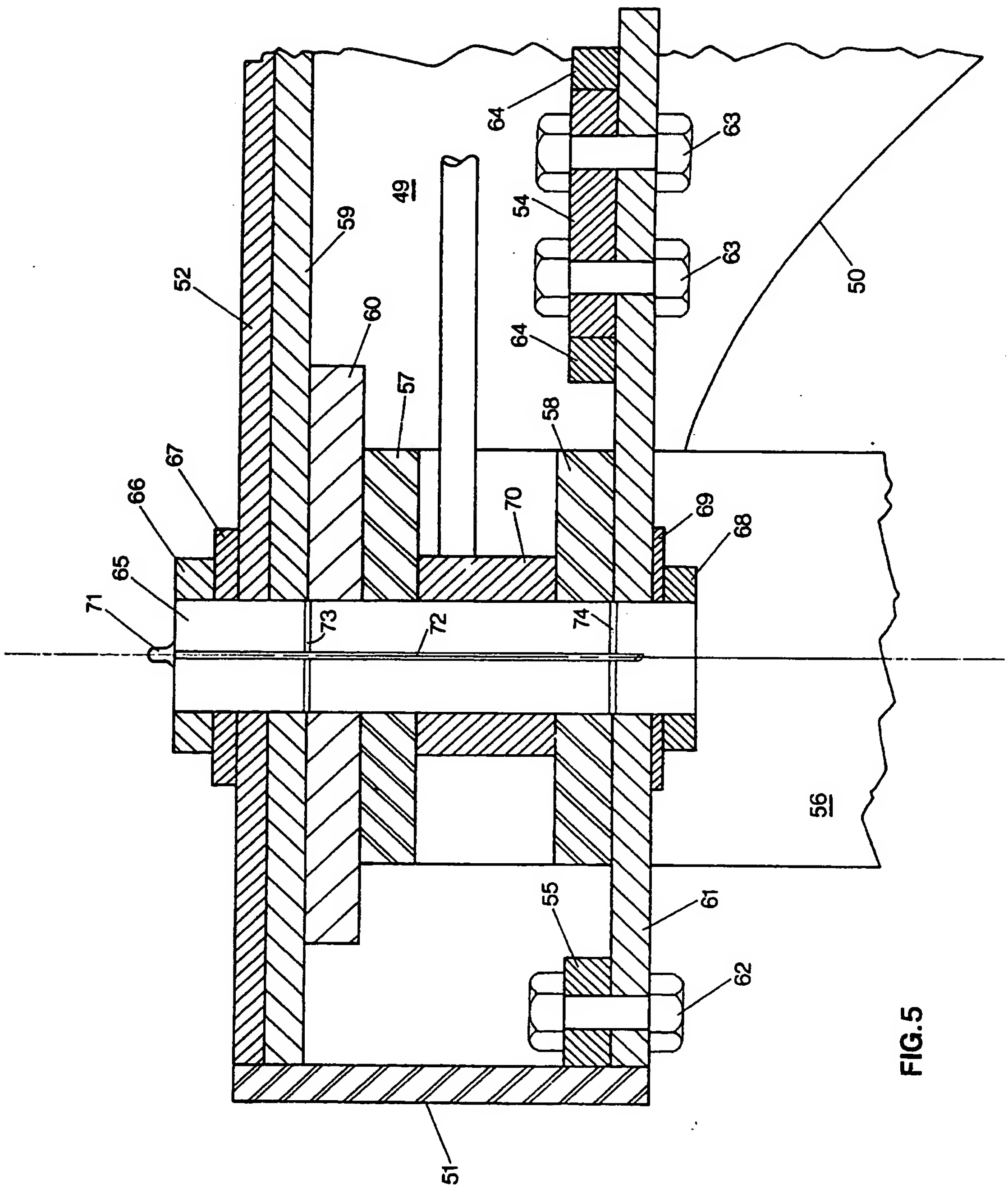
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FIG.5

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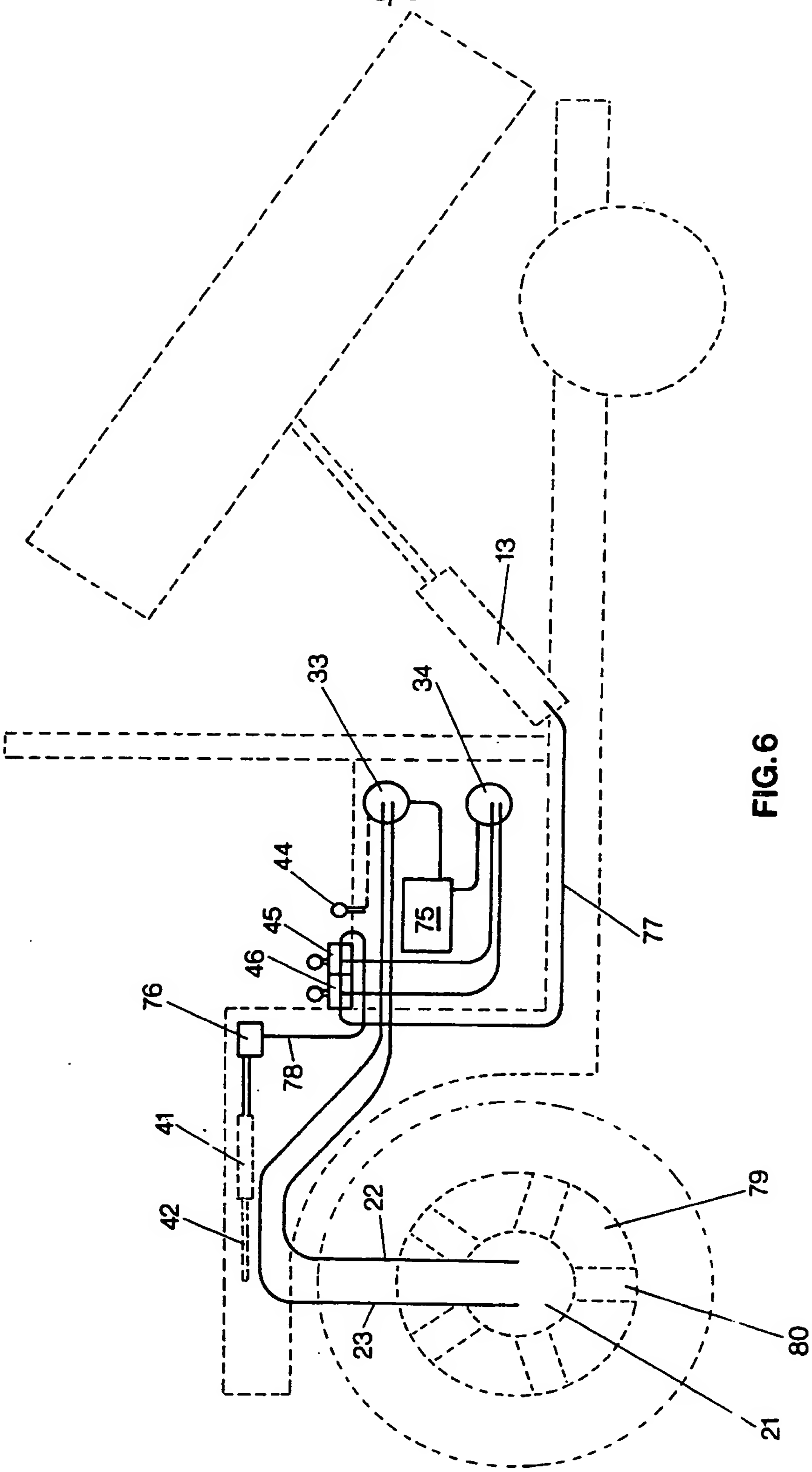

FIG.6

SPECIFICATION
Self-propelled three-wheeled vehicles

The present invention relates to a self-propelled vehicle and in particular to a three-wheeled motor vehicle suitable for transporting loads over terrain which would not permit the use of a normal road vehicle.

Vehicles such as tractors are well-known in which the drive is transmitted directly to the road and/or front wheels by a drive shaft or shafts or by means of chain and sprocket wheel transmissions. The gear box in a vehicle of this kind will normally have four to six speeds as well as a reverse gear. Accordingly such vehicles are relatively complex mechanically having large numbers of moving parts requiring regular maintenance and attention. The cost of such maintenance can accordingly be relatively large and a large inventory of spare parts may also be required. If it is necessary to move a load, a trailer must be attached to the tractor, as most tractors do not incorporate a load-carrying space. The fuel consumption of high-powered tractors is also usually considerable and may be excessive if the tractor has to be employed on lighter duties. Apart from the costs and complexity of keeping tractors of this kind in service, the first cost of such units is also substantial. For *inter alia* these reasons, conventional tractors have not been wholly successful in fulfilling the need existing in so-called "Third World" countries in particular for a relatively mechanically simple and rugged tractive and load carrying vehicle, equal to versatility to animal-powered carts but offering the improved performance and hauling capability arising from mechanisation.

It is an object of the present invention to provide a mechanically simple self-propelled vehicle, which will be capable of carrying a load over difficult terrain and which will be economical in both construction and operating costs. It is a particular object of the invention to provide such a vehicle for service in the less wealthy regions of the world, in substitution for animal-powered vehicles.

According to the invention, there is provided a self-propelled vehicle comprising a frame having a head section supported on a single steerably-mounted wheel provided with a positive displacement hydrostatic motor and a load-bearing section supported on at least two wheels disposed at opposite sides of the vehicle, and a variable-displacement motor-driven hydraulic pump for supplying hydraulic fluid under pressure to the hydrostatic motor.

In a preferred construction, the single wheel is mounted in a fork and the head section of the vehicle frame is rotatably supported at the upper end of the fork by bearing means. This bearing means may include at least one fixed thrust plate provided in the head section of the vehicle frame and abutting against a co-operating relatively rotatable thrust plate provided at the upper end region of the fork, the thrust plates being disposed substantially transverse to the steering axis of the single wheel. Preferably the bearing means includes an upper fixed thrust plate engaging against the upper face of an upper relatively rotatable thrust plate in the upper end region of the fork and a lower fixed thrust plate engaging the lower face of a lower relatively rotatable thust plate in the upper end region of the fork. The upper and lower fixed and relatively rotatable thrust plates are most suitably spaced apart along the steering axis of the single wheel. The bearing means preferably includes a pin, the end portions of which are accommodated in the upper and lower fixed thrust plates. Passages for lubricant are provided within the pin for distributing a suitable lubricant to the mutually engaging faces of the upper and lower fixed and relatively rotatable thrust plates.

In the particularly preferred embodiment of the invention, the head section is a structure of substantially box configuration, which is at least partially open in a substantially downward direction to receive the upper end of the fork. An upstanding bulkhead is then preferably provided at the end of the load-bearing section of the vehicle frame adjacent to the head section. This bulkhead may be defined at least in part by upstanding lateral pillars between which the end of the head section of the vehicle frame adjacent to the load-bearing section is received. According to a preferred feature of the invention, the steering axis of the single wheel substantially intersects the axis of rotation of the wheel for travelling movement of the vehicle. Because of the relatively low speeds at which it is intended the vehicle should be operated, it is not necessary for the axis of wheel rotation to be displaced from the steering axis by the customary caster angle. At the low speeds prevailing no adverse effects result from the coincidence of these two axes. It is further preferred that the steering axis of the single wheel is substantially vertical in the normal orientation of the vehicle on a level surface. These two features when combined substantially minimise bending moments on the forks supporting the wheel and allow a simple construction of upper fork bearing to be provided.

Also in the preferred construction of the vehicle of the invention, the hydraulic pump and the motor for the pump are mounted on the load-bearing section of the vehicle frame in a region adjacent to the head section. The motor for the hydraulic pump is most suitably a diesel engine, having for example one or two cylinders. An auxiliary motor-driven hydraulic pump may also be provided for supplying hydraulic fluid under pressure for auxiliary hydraulic apparatus mounted on or associated with the vehicle. The auxiliary pump is preferably driven by the motor supplying hydraulic fluid to the hydrostatic wheel-mounted motor. The auxiliary apparatus may include power steering means. A load-accommodating compartment is preferably provided on the load-bearing section of the vehicle frame, and in the case where this compartment is pivotably mounted, the auxiliary hydraulic

apparatus may include a tipping ram.

The l ad-carrying compartment may be of substantially rectangular box configuration, or it may be substantially V-shaped in cross-section and adapted for use in the spreading of bulk fertiliser. Three-way tipping may also be provided, so that side tipping is also facilitated. Means may be provided for mounting an auxiliary hydraulically-powered apparatus on the vehicle and hydraulic connecting means may then be provided for supplying such an auxiliary apparatus, when mounted on the vehicle, with hydraulic fluid delivered by the auxiliary pump. Such an auxiliary apparatus may include for example a fertiliser spreader or a spray unit, which may be mounted at the end of the load-bearing section of the frame remote from the head section. Where the vehicle is provided with a load-carrying compartment, means may be provided at the end of the vehicle remote from the head section for mounting an A-frame, to which such other equipment may be attached.

According to another aspect of the present invention, there is provided a head section for a self-propelled vehicle, having a single wheel associated therewith for rotation about a steering axis substantially perpendicular to the axis of roatation of the wheel for travelling movement and being receivable against a leading end region of a load-bearing section of the frame of a said vehicle. Preferably this head section is a structure of substantially box configuration and is at least partially open in a substantially downward direction to receive the upper end of a fork in which the single wheel is mounted.

In yet another aspect, the present invention provides a three-wheeled motor vehicle including a reservoir for hydraulic fluid, a hydraulic fluid pump powered by a prime mover and a hydraulic motor mounted in a front steerable wheel of larger diameter than the other two wheels. If extra traction is required, the rear wheels may also be hydraulically driven in addition to the larger diameter front wheel. The employment in the vehicle of the present invention of hydraulic drive, in which a hydraulic motor together with a hydraulic pump acts as a torque convertor and gives a variable speed power transmission means that the vehicle of the present invention can be driven in a significantly "lower" gear than that generally obtainable in vehicles with straight mechanical power transmission.

An embodiment of the self-propelled vehicle according to the invention will now be described having regard to the accompanying drawings, in which:

Figure 1 is a pictorial view of an embodiment of the self-propelled vehicle according to the invention;

Figure 2 is a side view of the vehicle of Figure 1;

Figure 3 is a view from above of the vehicle of Figures 1 and 2;

Figure 4 is a pictorial view from below f the head section and bulkhead lateral pillars f the frame of the vehicle of Figures 1 t 3;

Figure 5 is a transverse sectional view through the leading end of the head section of the frame of the vehicle of Figures 1 to 3, showing the bearing arrangement by which the front wheel of the vehicle may be pivoted about its steering axis, and

Figure 6 is a schematic diagram of a hydraulic system for the vehicle of Figures 1 to 3, the vehicle itself being shown in dotted outline.

As shown in Figures 1 to 3, the self-propelled vehicle according to the invention has a frame 1 with a front or head section 2 and a rear or load-bearing section 3. The load-bearing section 3 is made up of elongate lateral frame members 4, a transverse rear frame member 5, and one or more further lateral members at its leading end, not shown in the drawings. A transverse axle 6 has load-bearing wheels 7 mounted at its ends for rotation. For additional strength, the load-bearing or rear section of the frame may also have still further transverse or diagonal frame members, for example in the region of the axle 6. A substantially box-shaped flat open tipping body 8 is provided on the load-bearing rear section of the frame of the vehicle. Suitable dimensions for the body are 7'6" × 6', a size which will accommodate approximately two tons of material such as earth or gravel. The body is of conventional framed construction, with elongate frame members 9 and pillars 10. The body is pivotably mounted on the rear section 3 of the vehicle frame by means of pivots 11 in supports 12, so that the body can be tipped. A tipping ram 13 mounted on the vehicle frame section 3 raises the front end of the body for tipping in conventional manner. When the body is in its normal untipped position, its front end region rests on support pillars 14. The rear of the body 8, which is provided with an opening panel 15 of conventional construction, may also be provided with a top support 16 for mounting an A-frame 17 on the rear of the vehicle. Bottom supports 18 are provided on the rear frame section to support the lower extremities of the A-frame. This frame can be slid onto the rear of the vehicle to mount auxiliary equipment.

The head section 2 of the vehicle frame, the detailed construction of which is subsequently described in more detail, consists essentially of a generally box structure, in which a large front wheel 19 is steerably supported in a fork 20. The fork is pivotably mounted in a front region of the head section 2 for steering rotation. The large front wheel is also the driving wheel for the vehicle, and drive is achieved by a positive-displacement hydrostatic motor mounted in the hub 21 of the wheel 19. Hydraulic fluid under pressure is supplied to the motor from a pressure pump, to be described subsequently, through a feed hose 22, and the hydraulic fluid returns to the pump through a return line 23. The lines 22 and 23, which consists of high pressure hydraulic hoses, terminate at a block 24 mounted on one side of the fork at its lower end, in the region of the hub 21 of the wheel which accommodates the

hydrostatic motor. A drain line 25 extends from the block 24 to a hydraulic reservoir in the vehicle and brings back to the reservoir any hydraulic fluid accumulating in the block 24, as a result of leakage past seals or the like.

A preferred wheel size is 11 × 28. The diameter of the tyre when inflated is approximately 47 inches overall, and the width of the tyre at its widest point is approximately $12\frac{1}{2}$ inches. The positive displacement hydrostatic motor is of generally conventional design, and the use of such motors in wheel hubs is known. In particular construction, five pistons equiangularly disposed about the axis of the wheel act against a lobed cam. The number of hydraulic cylinders and pistons acting against the cam being odd, the vehicle can always be started, as there is no dead position. Hydrostatic motors of this kind are fully bidirectional, the roles of the feed and supply lines simply being interchanged if it is desired to operate the vehicle in reverse. Speed control may be achieved by varying the rate of pumping of the hydraulic fluid, as subsequently described. The head section of the vehicle frame is connected to the rear or load-bearing section by means of a bulkhead 26, which is defined in part by upstanding lateral pillars 27, located at the front end of the elongate lateral members 4 of the rear frame section 3. The rear end of the head section 2 is received between these lateral pillars 27 and defines the remaining intervening portion of the bulkhead. At the lower ends of the lateral pillars 27, triangular corner brace plates 28 rigidify the structure, these plates being welded to both the pillars 27 and the side frame members 4. It is preferred that the various frame members and structural portions be connected together by welding, but the construction may be fabricated, using bolted connections, if preferred, or where the means available for construction do not include welding equipment. In particular the rear end of the head section may be bolted to the upstanding lateral pillars 27, as subsequently referred to in more detail.

Behind the bulkhead 26, a transverse driver-accommodating space 29 extends across the vehicle. In the centre of this space, a tunnel 30 accommodates the hydraulic lines coming from the head section towards the power unit, which is housed to the rear of the driver space 29. Access to the driver space can be seen to be easy, and a passenger can be accommodated in the free space on the other side of the tunnel. Behind the drive space and beneath the driver's seat 31, the power unit for the vehicle is housed. A diesel engine 32, most suitably an 18 horsepower two cylinder air-coooled unit, drives a variable displacement swash plate pump 33 and an auxiliary pump 34 for supplying hydraulic fluid for steering and tipping purposes. A header block 35 is provided for directing the feed from the auxiliary pump 34 to the various pieces of auxiliary equipment or appliances to be supplied, and incorporates a bleed relief valve. As shown in Figure 3, the engine is located on the left hand side of the vehicle considered with respect to its forward direction, the main pump 33 is a little to the right of the centre line and the auxiliary pump and header block are disposed more or less immediately beneath the driver's seat. This arrangement of the units gives good balance of the weight of the components, so that they are substantially equally distributed about the vehicle longitudinal axis. The engine cover and seat are displaceable so that they can be readily removed for access to the power unit compartment for maintenance or examination purposes. For example the cover 36 may be hinged about a pivot axis indicated at 37. Holes 38 in the end panels 39 of the power unit housing provide for the ready admittance of cooling air.

The vehicle controls are grouped together in convenient manner close to the driver on the rear of the bulkhead 26 and on the tunnel 30. A steering wheel 40 is coupled with a power steering transmitter in the form of a suitable valve which drives the power steering receiver or ram 41. The leading end of the piston 42 of the ram 41 is pivotably connected to an upper end portion of the fork 20 at a point laterally spaced from its pivoting or steering axis, so that steering of the vehicle is achieved by operation of the ram 41. Control of the vehicle speed is achieved by a combination of engine speed and swash plate pump setting. The engine speed is controlled in conventional manner by the engine governor through a pedal operated throttle, the pedal 43 being indicated in Figure 3. The angle of the swash plate is controlled by lever 44 mounted on the tunnel, for forward and rearward movement. Forward movement of the lever increases the angle of the swash plate and accordingly the quantity of fluid being pumped. When the lever is in its central position no fluid is pumped and when the lever is moved rearwardly, fluid is pumped in the reverse direction, to drive the vehicle backwards. Control of vehicle speed is described in more detail subsequently, in regard to a later Figure. The remaining controls consist of an ancillary apparatus selection lever 45, which allows the hydraulic fluid from the auxiliary pump to be directed to either the steering valve and ram or the tipping ram. If tipping is selected by valve 45, actual control or the rate and duration of tipping takes place by valve 46. Lever 47 is the manual parking brake, to comply with legal requirements for use on the public roads.

Immediately behind the power unit compartment, an anti-rollover bar 48, in the shape of an inverted U, is welded at its lower extremities to the lateral side members 4 of the vehicle frame rear section 3. This is intended to provide protection for the driver in the event of the vehicle tipping over during use. The space inside the U-shaped bar may also be substantially filled with a mesh structure or a panel, with holes for visibility, to protect the driver against loads on the body 8 moving forward in the event of accident or sudden stop. The vehicle of the invention is not provided with any springing, as its maximum speed is

relatively l w and its primary intended area of use is off public roads or in bad conditions. The tyres used do however provide a degree of primary springing.

Referring now to Figure 4, the head section of the frame 1 of the vehicle is of generally box construction, being open in a downward direction over part of its extent to accommodate the upper end of the fork 20. In side view the head section has substantially the form of a right-angled triangle, the longer side of which extends diagonally downwardly from the front of the head section but is dished to accommodate the steering action of the wheel 19. Accordingly the head section has lateral members 49 of plate configuration having curved lower edges 50. The plates are spaced apart in a transverse direction and at their front ends they are curved around and welded together so as to define a curving front nose portion 51 of the head section 2. The side plates 49 are spaced apart on top by a welded-on top plate 52 and in their lower region by a welded-in curved plate 53. The curved plate 53 does not extend along the entire length of the curved edges 50 of the plates 49, but terminates short of the upper end of these curved edges, so that the front portion of the head section is open downwardly to receive the top end of the fork 20. Within the box formed by the plates 49, 52 and 53, a transverse spacing plate 54 provides added strength to the box structure and also aids in mounting the fork bearing, as described subsequently. In the front nose region of the head section, a further transverse plate 55, with a suitably curved edge along one side, is welded into the box structure, to further rigidify it and also to accommodate the fork bearing structure.

Figure 4 also shows the lateral vertical pillars 27 which extend upwardly at the leading end of the rear or load-bearing section of the frame and in part define the bulkhead 26. As can be seen from Figure 4, the rear end of the head section is accommodated between these pillars. It may be welded in this position or alternatively it may be bolted in and located between the pillars, which are of hollow box section, either by locating holes or by suitably mounted plates providing locating edges. In this way prefabricated construction of the vehicle of the invention may be facilitated.

The bearing arrangement for the head of the fork 20 is shown in Figure 5. The fork 20 has lateral substantially vertically extending side members 56, which are bridged at their upper ends by transverse members 57 and 58. These members are in the form of plates and are spaced apart in the vertical direction. Member 57 defines a thrust plate, to the upper surface of which a bearing surface thrust plate 60 is welded. The upper surface of plate 60 is a bearing surface. Member 58 defines a lower thrust plate and its lower surface is in this case the bearing surfac . Within the box structure head section 2 of the vehicle frame, the top plate 52 is reinforced by a further fixed thrust plate 59 in the front bearing region, the lower surface of which is a bearing surface engaging the upper surface of the plate 60. These plates may be welded to the b x plate 52 and fork top transverse member 57 respectively, or if required may be bolted, for easy replacement in the event of wear of the bearing surfaces. The upper bearing surfaces transmit and carry the greater proportion of the load on the front wheel.

A lower thrust bearing arrangement is provided by an elongate plate 61, which is bolted at its front end to the transverse head section plate 55 by bolts 62. At its rear end the plate 61 is bolted to the transverse reinforcing plate 54 of the head section by bolts 63. Upstanding locating bars 64, welded to the upper surface of the plate 61 transverse to its elongate direction, locate the plate 61 with respect to the plate 54 by abutment against the transverse edges of plate 54. The upper surface of plate 61 defines a bearing surface which engages a co-operating bearing surface on the lower face of the thrust plate 58. Accordingly this plate takes any bearing loads directed in a downward direction. However it will be clear that such loads will be relatively modest compared with those exerted on the upper bearing surface and replacement of the lower bearing plate should be required in normal use at only infrequent intervals, if at all.

The bearing assembly is held together by a pin 65 preferably of $2\frac{1}{2}$ inches diameter and formed from bright steel. The ends of the pin are held in the plates 52 and 61 respectively by suitable means such as nuts 66 and 68 respectively and washers 67 and 69. Accordingly it will be seen that the plate 61 not only serves to provide a bearing surface for thrust directed in a downward direction, but also locates the pin 65 in a positive manner to define the steering axis of the wheel 19. A spacing collar 70 surrounds the pin between the upper and lower transverse members 57 and 58 of the fork head. The entire bearing assembly can be readily dismounted for maintenance or replacement by removal of the pin 65 and release of the bolts 62 and 63. Lubrication of the bearing surfaces is provided for by means of a single grease nipple 71 on the upper end of the pin 65 communicating with a central grease passage 72 in the form of a bore along the axis of the pin 65. Lateral bores or passages 73 and 74 communicate between the central bore and the bearing surfaces and radial grooves in the bearing surfaces allow the grease to travel out from the pin to ensure that lubricant is distributed over the entire bearing surface. Because of the use of hydraulics in the vehicle of the invention, the grease nipple 71 is the sole such point required in the entire drive and steering arrangements of the vehicle.

As can be seen from Figure 5 and from Figure 2, the steering axis, which is defined as the axis about which the fork is rotatable, is substantially vertical when the vehicle is in its normal orientation on level ground. It will also be seen from Figure 2 that the axis of rotation of the wheel, i.e. the axis about which it rotates during

travelling, substantially intersects the vertical steering axis of the vehicle. In this respect, the vehicle of the invention, in the preferred embodiment, differs from many other steerable vehicles and in particular from many steerable vehicles using a fork mounted steerable wheel, firstly in that the steering axis is substantially vertical, and secondly in that no caster angle is provided. It has been found that steering of the vehicle is effective without these features. It will be seen that by avoiding a caster angle, substantially all of the load transmitted to the fork by the wheel and sustained by the fork bearing is directed in a substantially vertical upward direction. Accordingly excessive bending moments on the limbs 56 of the fork are avoided as is the necessity to allow for any significant degree of lateral loading on the bearing. Accordingly the simple and practical plain thrust bearing described can be employed in the vehicle of the invention.

A suitable hydraulic system for the vehicle of the invention is illustrated schematically in Figure 6. In addition to items referred to in connection with the previous drawings, this drawing additionally shows a hydraulic fluid reservoir 75 from which the swash plate and auxiliary pumps may be fed as necessary. The drain lines which return fluid from the front fork block 24 and the bleed valves are not shown. As already described, the swash plate pump supplies hydraulic fluid to the hydrostatic motor in the front wheel through a supply line 22 for forward motion and the fluid returns to the pump through line 23. For rearward motion, the direction of flow is reversed. Control of the vehicle speed is achieved by a combination of throttle control using the pedal and the swash plate angle, controlled by the lever 44. To increase vehicle speed at a constant throttle setting, the swash plate lever 44 is moved further forward, or backward as the case may be. This variation of the swash plate angle alters the output of the pump. At a given swash plate angle, the pump output may also be increased by increasing the engine speed. Pump output pressure is substantially constant regardless of engine speed or swash plate setting. In use of the vehicle, a combination of lever position and throttle setting will normally be used. For example a particular speed may be chosen on level ground by selection of a swash plate lever position, and this speed maintained when the vehicle moves on to an incline by increasing the engine speed. However individual drivers will select different modes of operation depending on their preferences. It is envisaged that in normal use the driver would maintain his hand continually on the swash plate lever and operate the steering with his other hand. Direct mechanical operation of the swash plate by lever 44 is preferred for mechanical simplicity and economy, but if desired lever 44 may be coupled with a servo valve and the swash plate angle controlled through a suitable servo system.

The hydraulic system f r the ancillary equipment is also schematically illustrated. The output from auxiliary pump 34 passes through selection valve 45 which directs it to either the steering transmitter valve 76 or to a tipping control valve 46. Where a single auxiliary pump is used it is not in general possible to steer and tip simultaneously. However the vehicle may be steered while the tipping ram is being bled off to lower the body into its normal position. The particular arrangement in which tipping or steering may be selected minimises the complexity of the system and does not constitute any significant disadvantage. The tipping ram is fed through a line 77, whole line 78 feeds the steering valve 76. Further ancillary equipment may also be fed by suitable hydraulic fluid supply lines.

The steering transmitter or valve 76 may be a spool valve, in which case operation of the steering is initiated by any movement of the steering wheel 40 and continues until such time as the steering wheel is restored to a central position, or alternatively and preferably it may be a proportional valve so that the degree of steering is related substantially directly to the extent to which the steering wheel is turned. The piston 42 of the steering ram 41 is pivotably connected to the upper end region of the fork 20, for example by means of a further pin extending substantially vertically between the plates 57 and 58 to one side of the central bearing pin 65. The lateral spacing between the axis of the pivot mounting of the piston 42 and that of the bearing pin 65 determines the steering torque exerted on the fork by the steering ram. The steering wheel may also be provided with a latch mechanism for locking the steering, so that the vehicle can be driven slowly in a circle, for example for spraying or distributing granulated material. Where a servo system is provided for the swash plate pump, or a lockable manual lever 44, it may be possible in some circumstances for the driver to allow the vehicle to continue in this way while he attends to equipment at the rear of the unit.

The manner of use of the vehicle will be largely self-explanatory from the description of its construction already given. It is driven in accordance with the principles set out above and by virtue of its high degree of manoeuvrability, it can gain access to many awkwardly placed locations without undue difficulty. The tipping facility allows loads to be deposited at will where required. The vehicle is particularly suitable for use in bad conditions, such as rough fields and the like, and a high degree of stability is achieved by the choice of a suitable wheel base.

As shown in the drawings the rear wheels are slightly outboard of the vehicle body, but in alternative constructions, the wheels may be located beneath the vehicle body. The preferred maximum speed of the vehicle is approximately 13½ m.p.h. With an 18 h rsepower two cylinder air cooled diesel engine, the maximum fuel consumption under full load conditions amounts to approximately one gallon per hour. In normal use, with a mix of full power running and lesser p wer running, a fuel consumption f two gallons

per hour would be more usual. This allows for very economical operation of the vehicle of the invention.

As already mentioned in connection with Figure 3, an A frame can be mounted on the rear of the vehicle by means of suitable supports. Further equipment can then be mounted in turn on this frame, for example a fertiliser spinner or spreader or a spray unit. The provision of the A frame allows three point mounting of such units in similar manner to the arrangements available on the rear of a conventional tractor. The hydraulic system may also allow for feed of hydraulic fluid to hydraulically driven apparatus on these ancillary units. Suitable connections can be provided by further high pressure hoses and suitable additional valve arrangements provided in the hydraulic circuitry.

A further advantageous feature of the vehicle according to the invention is its suitability for modular construction. One possibility for this is the construction of the rear loading-bearing section together with the upstanding bulkhead pillars 27 as a single unit and the provision of the head section as a separate unit. The head section 2 can then be bolted or welded into position between the bulkhead pillars and located in assembly by means of suitable holes and bolts or pins or locating bars providing locating edges similar to those for the lower bearing plate within the head section. In this way the rear section of the vehicle, which can be constructed in technically very simple circumstances, could be fabricated locally, for example in a third world country, while the technically more complex head section could be supplied from outside that country, together with the power unit including pumps and high pressure hoses, for association with the rear section of the unit in the country in question.

The vehicle of the invention provides an economical and technically simple and maintenance-free construction of unit suitable for a wide variety of load-carrying purposes. It is seen as a versatile substitute for animal-powered vehicles in the lesser developed countries, and offers the particular advantage of economical and relatively maintenance-free operation together with simplicity and economy of construction. It is also suitable for use in more developed countries, in particular on farms, but also on building sites, stud farms and for refuse collection in city streets, where its relatively low speed capabilities would not be disadvantageous. It may also be fitted with alternative forms of motive power unit, e.g. a gas engine, if required to operate in closed environments where the emission of noxious exhaust fumes would be either a hazard or offensive.

CLAIMS

1. A self-propelled vehicle comprising a frame having a head section supp rted on a single steerably mounted wheel pr vided with a p sitive displacement hydrostatic m tor and a l ad-bearing section supported on at least two wheels disposed at opposite sides of the vehicle, and a variable displacement motor-driven hydraulic pump for supplying hydraulic fluid under pressure to the hydrostatic motor.

2. A self-propelled vehicle according to Claim 1, wherein the single wheel is mounted in a fork and the head section of the vehicle frame is rotatably supported at the upper end of the fork by bearing means.

3. A self-propelled vehicle according to Claim 2, wherein the bearing means includes at least one fixed thrust plate provided in the head section of the vehicle frame and abutting against a co-operating relatively rotatable thrust plate provided at the upper end region of the fork, the thrust plates being disposed substantially transverse to the steering axis of the single wheel.

4. A self-propelled vehicle according to Claim 3, wherein the bearing means includes an upper fixed thrust plate engaging against the upper face of an upper relatively rotatable thrust plate in the upper end region of the fork and a lower fixed thrust plate engaging the lower face of a lower relatively rotatable thrust plate in the upper end region of the fork.

5. A self-propelled vehicle according to Claim 4, wherein the upper and lower fixed and relatively rotatable thrust plates are spaced apart along the steering axis of the single wheel.

6. A self-propelled vehicle according to Claim 4 or Claim 5, wherein the bearing means includes a pin, the end portions of which are accommodated in the upper and lower fixed thrust plates.

7. A self-propelled vehicle according to Claim 6, wherein passages for lubricant are provided within the pin for distributing lubricant to the mutually engaging faces of the upper and lower fixed and relatively rotatable thrust plates.

8. A self-propelled vehicle according to any of Claims 2 to 7, wherein the head section is a structure of substantially box configuration, at least partially open in a substantially downward direction to receive the upper end of the fork.

9. A self-propelled vehicle according to any preceding claim wherein an upstanding bulkhead is provided at the end of the load-bearing section of the vehicle frame adjacent to the head section.

10. A self-propelled vehicle according to Claim 9, wherein the bulkhead is defined at least in part by upstanding lateral pillars between which the end of the head section of the vehicle frame adjacent to the load-bearing section is received.

11. A self-propelled vehicle according to any preceding claim, wherein the steering axis of the single wheel substantially intersects the axis of rotation of the wheel for travelling movement of the vehicle.

12. A self-propelled vehicle according to any preceding claim, wherein the steering axis of the single wheel is substantially vertical in the normal orientation of the vehicle on a level surface.

13. A self-propelled vehicle according to any preceding claim, wherein the hydraulic pump and the motor for the pump are mounted on the load-

bearing section of the vehicle frame in a region adjacent to the head section.

14. A self-propelled vehicle according to any preceding claim, wherein the motor for the hydraulic pump is a diesel engine.

15. A self-propelled vehicle according to any preceding claim, wherein an auxiliary motor driven hydraulic pump is provided, for supplying hydraulic fluid under pressure for ancillary hydraulic apparatus mounted on or associated with the vehicle.

16. A self-propelled vehicle according to Claim 15, wherein the auxiliary pump is driven by the motor for the pump supplying hydraulic fluid to the hydrostatic motor.

17. A self-propelled vehicle according to Claim 15 or 16, wherein the ancillary apparatus includes power steering means.

18. A self-propelled vehicle according to any preceding claim, wherein a load accommodating compartment is provided on the load-bearing section of the vehicle frame.

19. A self-propelled vehicle according to any of Claims 15 to 17, wherein a load accommodating compartment is pivotably mounted on the load-bearing section of the vehicle frame and said ancillary hydraulic apparatus includes a tipping ram.

20. A self-propelled vehicle according to any of Claims 15 to 17, Claim 18 when dependent on any of Claims 15 to 17, or Claim 19, wherein means are provided for mounting ancillary hydraulically powered apparatus on the vehicle and hydraulic connecting means are provided for supplying such ancillary apparatus, when mounted on the vehicle, with hydraulic fluid delivered by the auxiliary pump.

21. A three-wheeled motor vehicle including a reservoir for hydraulic fluid, a hydraulic fluid pump powered by a prime mover and a hydraulic motor mounted in a front steerable wheel of larger diameter than the other two wheels.

22. A self-propelled vehicle according to any preceding claim, wherein at least one further wheel of the vehicle is also provided with a positive-displacement hydrostatic motor.

23. A head secti n for a vehicle according to any preceding Claim having a single wheel associated therewith for rotation about a steering axis substantially perpendicular to the axis of rotation of the wheel for travelling movement, the head section being receivable against a leading end region of the load-bearing section of the frame of said vehicle.

24. A head section according to Claim 22, wherein the head section is a structure of substantially box configuration and is at least partially open in a substantially downward direction to receive the upper end of a fork in which the single wheel is mounted.

25. A self-propelled vehicle substantially as described herein with reference to or as illustrated in the accompanying drawings.

26. A head section for a self-propelled vehicle substantially as described herein with reference to or as illustrated in Figures 1 to 5 of the accompanying drawings.

Superseded claims 1, 23, 24, 25 and 26.
New or amended claims:—

1. A self-propelled vehicle comprising a frame having a head section supported on a single steerably mounted wheel provided with a positive displacement hydrostatic motor mounted in the wheel, a variable displacement motor-driven hydraulic pump for supplying hydraulic fluid under pressure to the hydrostatic motor, and a load-bearing section supported on at least two wheels disposed at opposite sides of the vehicle, the steerably-mounted wheel being of larger diameter than the wheels on which the load-bearing section of the frame is supported.

23. A head section for a vehicle according to any preceding Claim.

24. A self-propelled vehicle substantially as described herein with reference to or as illustrated in the accompanying drawings.

25. A head section for a self-propelled vehicle substantially as described herein with reference to or as illustrated in Figures 1 to 5 of the accompanying drawings.

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